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Economic Intelligence Report

THE CONSTRUCTION OF HIGHWAYS IN COMMUNIST CHINA
1949-60



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CENTRAL INTELLIGENCE AGENCY

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FOREWORD

The construction, improvement, and maintenance of the highway system in Communist China became increasingly important during the First Five Year Plan (1953-57) and particularly so during the "leap forward" movement in the early years of the Second Five Year Plan (1958-62). Although the highway system is supplementary to other forms of transportation, it has an economic, political, and military importance especially in frontier areas where railroads and waterways are underdeveloped or lacking. This report assesses the highway construction performance and indicates probable future construction trends. The report also attempts to resolve some of the ambiguities that permeate Chinese Communist reporting on highway construction.

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THE CONSTRUCTION OF HIGHWAYS IN COMMUNIST CHINA*
1949-60

Summary and Conclusions

The highway system** of Communist China is a low-grade system by Western standards because it is characterized by a predominance of soil-aggregate and natural earth roads,*** low-capacity bridges, and numerous ferry crossings. Except in certain areas where other transportation facilities are underdeveloped or lacking, roads serve primarily as feeder lines to railroads and waterways and for short-haul traffic between cities.

During the period 1949-59, about 470,000 kilometers (km) of highways were newly constructed or repaired.† Of the total capital investment of some 1.12 billion yuan†† for highway construction during 1953-57, the major share was allocated for the construction of new roads in frontier regions and minority areas located mainly in the western sections of the country. Throughout the other areas of the country, the remaining share was allocated for some new construction, but the largest part went for repair and improvement of the existing system. It was not until 1956 that an equivalent of the pre-1949 200,000-km highway system was regained and open to traffic. The 270,000 km of new roads constructed during the 10-year period were primarily soil-aggregate and natural earth roads. The construction of earth roads increased after 1956, gaining the greatest momentum during 1958. This trend toward increased construction of natural earth roads apparently will continue at least through 1968. Probably less than 1 percent of the total of the roads constructed during the past 10 years could be called high-speed hard-surfaced highways. Currently it is planned that, by the end of 1962, highways will reach a total length of more than 600,000 km.

* The estimates and conclusions in this report represent the best judgment of this Office as of 1 December 1960.

** Probably the most common use of the term highway is to describe a public road or thoroughfare. In this report the terms highway and road are used interchangeably.

*** For a description, see the glossary, Appendix A, p. 21, below.

† See the map, Figure 6, inside back cover.

†† Equal to about US \$455 million at the implied rate of exchange of 2.46 yuan to US \$1. All yuan values in this report

are believed to be in current yuan.

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Highways in Communist China have not been constructed according to specifications and have not been properly maintained, with the result that failures occur frequently. Moreover, continued construction of soil-aggregate and natural earth roads, when added to a highway system already subject to rapid deterioration, aggravates the problems of maintenance and repair. Because there is no indication that the character or function of the Chinese highway system will change greatly during the next 10 years (1960-70), the highway system will continue to be supplementary to other forms of transportation, and the maintenance and repair problem will continue to mount.

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I. Introduction

In Communist China the nomenclature used to describe the highway system and the statistical reporting on the kind and amount of work performed are equivocal and enigmatic. It is difficult, for example, to relate the kinds of road surfaces to the types, classes, or functional use of highways or to determine what is included under new construction, improvement, renovation, or repair when such terms are used in relation to an amount of construction work performed. Data on the amounts of construction are frequently not related to a specific type of road with any consistency. Moreover, one type of road may be referred to by several different terms.

In general, however, the Chinese Communists list the types of roads as follows: motor highways, designed primarily for use by motorized traffic; simple highways, designed primarily for use by motorized traffic, agricultural tractors, and big carts; big cart roads, intended primarily for use by big carts and trafficable by motor vehicles but not by loaded trucks; and pack roads, intended for use by pack animals but not by wheeled vehicles.

Motor highways are divided into classes according to traffic capacity. By improving the road surface and bridges and thereby increasing capacity, the classification of a road is changed. This practice undoubtedly accounts for inflation of statistics on new construction and some double counting.

Functionally, roads are broken down roughly into national, provincial, and intraprovincial roads depending on their economic, military, and political importance, connections or terminals, and volume of traffic. Also used to describe function by the Chinese Communists is the term trunk highways, which probably includes national routes, main roads in remote areas, and the only road in a significant area. Because about 50 percent of the roads in the highway network are designated as military roads, probably any motorable road, regardless of type, classification, or location, is considered a military asset to the state if it provides proper access.

II. Responsibility for Construction

Since about 1952, responsibility for the construction and maintenance of a highway system in Communist China has been the function of the Central Highway Bureau, which is subordinate to the Ministry of Communications. During the period of the First Five Year Plan (1953-57), emphasis was placed on the establishment of a national road network to serve the economic, political, and military interests of the state. The activity of the Central Highway Bureau, therefore,

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although it included some control over highway transport, probably was weighted more toward highway construction. In the same period (1953-57) the provinces, autonomous regions, and other levels of government apparently were responsible for some highway construction within their areas of administration.

In 1958, at the beginning of the Second Five Year Plan (1958-62), some of the highway surveying, designing, and construction forces that were directly under the control of the central government were transferred to the provincial and regional levels. 1/* This shift implied that local authorities were to have more responsibility for future highway construction including some sections of national routes.

In 1959 the Central Highway Bureau had departments and institutes still functioning in the field of highway survey and design, planning, engineering, and scientific research. 2/ In addition, there was a highway department associated with the Central Highway Bureau, the activities of which may have included supervision of completed highways, repair and maintenance, some control of highway transport, and some coordinating functions with the provinces in relation to these and other activities. In general, the Central Highway Bureau probably retained certain over-all functions of coordination and supervision to insure that national routes, interconnecting provincial routes, and routes to important economic centers were kept open and maintained and to insure that the highway network would be planned and expanded to support increased transport as needed.

III. Performance in Highway Construction, 1949-60

In Communist China the highway system lags far behind railroads and inland waterways as a transportation facility. In most parts of the country, roads are used primarily to feed traffic to railroads and waterways or to carry short-haul traffic between cities. Only where adequate rail or water routes are not available are highways used for long-haul traffic. The system is composed primarily of soil-aggregate and natural earth roads, and even as late as 1960 there probably were fewer than 1,000 km of high-speed hard-surfaced highways.**

During the 10 years 1949-58 it was claimed that a total of more than 409,000 km*** of highways were newly constructed and repaired.†

** The Peking - T'ang-ku highway and roads in most large urban areas are higher grade roads.

*** All reported kilometer figures in this report have been rounded.

† These two terms probably include all types of work (new construction, improvement, and repair and maintenance) performed on roads during the period. For a definition of these terms, see the glossary, Appendix A, p. 21, below.

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Of this total, 237,000 km, or 58 percent, were newly constructed, and the remaining 172,000 km were repaired. By the end of 1958 the total length of roads in operation was reported as 400,000 km.* ^{3/} The figures for total highway construction and repair for the 10-year period indicate that a greater length of new roads was constructed than was repaired. However, a breakdown by year of these totals into the amount and type of work performed annually, as shown in Table 1,** is more revealing. Initial repair of the highway system continued well into the period of the First Five Year Plan, and probably it was not before 1956 that most of the pre-1949 system, in terms of length, was restored to use.*** Furthermore, the figures for new construction for the years 1956-58 were inflated by including the length of very low-grade rural (earth) roads added during the 3-year period.

A. Restoration Period, 1949-52

In 1949 the Chinese Communists inherited a low-grade highway system, characterized by roads with little or no surfacing and low capacity bridges and ferries. Geographically the highway network was concentrated in the northern and eastern maritime provinces, with a limited number of roads in other areas of the country. In 1949, about 75,000 km of roads were reported to be usable[†] out of an estimated total network of some 200,000 km established under the Chinese Nationalists. During the restoration period (1949-52), construction efforts were concentrated on restoring the network to traffic, but construction was started on a few new highways, especially in the northwest and southwest areas of the country. In addition, highways of military importance were constructed in the Liaoning and Shantung peninsulas, in Fukien Province, and on Hainan Island. ^{5/}

B. First Five Year Plan (1953-57)

During the period of the First Five Year Plan (1953-57) a total of about 153,000 km of highways was newly constructed and repaired. ^{6/}

* In the US, an area (48 states only) about 1.5 million square kilometers (sq km) smaller, the length of soil-aggregate and natural earth roads in 1958 was about nine times as great as on mainland China. ^{4/}

** Table 1 follows on p. 6.

*** The length of the original system before 1949 is estimated to be 200,000 km.

[†] Inasmuch as the 75,000-km figure is consistently reported for 1949, it probably refers to the length of roads usable at the time when the Communists took control in the fall of the year and is not a year-end figure as shown in Table 1.

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Table 1

Communist China: Additions to the Highway System
1949-59

Date	Amount of Construction and Repair					Length in Operation
	Total a/ (Kilometers)	New Construction a/ (Kilometers)	Percent of Total	Repair b/ (Kilometers)	Percent of Total	Total a/ (Kilometers)
1949	N.A.	N.A.		N.A.		80,800
1950	15,500	500	3	15,000	97	99,600
1951	19,500	1,400	7	18,100	93	114,400
1952	11,200	1,900	17	9,300	83	126,700
1953	9,700	2,600	27	7,100	73	137,100
1954	7,200	3,800	53	3,400	47	146,100
1955	8,100	3,600	44	4,500	56	167,300
1956	89,700	55,900	62	33,800	38	226,300
1957	38,200	17,500	46	20,700	54	254,600
1958	210,000	150,000	71	60,000	29	400,000
1959	72,000 c/	48,000 c/	67	24,000 c/	33	450,000 d/

a. 7/. The total annual figure for the amount of construction and repair completed cannot be added to the previous year's total length in operation to obtain the new total length in operation. Annual repair work is performed on roads in use and also brings roads into use. Therefore, the amount of construction and repair in any 1 year exceeds the total length in operation at the end of the year. The discrepancy in the table between these two totals for some years probably is accounted for by poor statistical reporting. Also, the total annual figures for the amount of construction and repair in this table are conservative when compared with earlier figures announced annually.

b. Residual.

d. Estimated.

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Top priority was accorded to the construction of highways in the frontier regions and along the sea coast. By the end of 1957 a total of more than 12,000 km of roads had been constructed by the central government, 9/ exceeding the original plan target of about 10,000 km by 20 percent. The most important of these national highways were the 2,255-km Sikang-Tibet (Ya-an - Lhasa) (see the accompanying photograph, Figure 1), the 2,100-km Tsinghai-Tibet (Hsi-ning - Lhasa); and the



Figure 1. Communist China: Section of the Sikang-Tibet Highway, Tibet

1,200-km Sinkiang-Tibet (Karghalik-Gartok) highways. Other important highways constructed by the central government were built through the Tsaidam Basin, to the Karami oil fields, and to various major mining and industrial areas. In addition to highways constructed by the central government, a total of more than 112,000 km of highways was constructed by local authorities. 10/ These roads included feeder lines to railheads and waterways, intraprovincial connecting roads, and roads in urban areas. In 1955, in conjunction with the socialization of agriculture, the national conference on communications proposed an immediate extension of the road system. In the off seasons, peasants

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were mobilized for the construction of simple highways, with the result that in the 2 years 1956-57 a total of 100,000 km* of this type of road was constructed. 11/

C. Second Five Year Plan (1958-62)

During 1958, construction of roads was intensified, a situation that was brought about by increased transport demands and emphasis on water conservancy. Of the total of about 150,000 km of new roads constructed during the year, 93 percent, or 140,000 km, were simple highways constructed in rural areas. 12/ New roads were built connecting hsiens, communes, and other areas previously lacking roads. Construction also involved changing the road pattern by eliminating some roads and realigning others where they conflicted with the construction of water conservancy projects or chopped up land needed for cultivation. 13/ Probably the major part of the 80,000 km of roads reported in February 1960 as the length added to the highway system since 1958 were simple highways. The plan for 1960 called for the continued construction of simple highways, which was to be carried out by local authorities and communes. It was planned also that a total of 6,500 km of highways, apparently national and main provincial roads, were to be constructed and that 25,000 km in addition were to be repaired. 14/

In January 1960, at a national conference convened by the Central Highway Bureau of the Ministry of Communications, plans for a 3-year and an 8-year program of highway construction were formulated, 15/ but the length of highways to be constructed by the end of the two plan periods was not announced. A goal announced earlier in 1956 for the total length of highways to reach 600,000 km by the end of 1962 may still be in effect. To meet this 600,000-km target, an average of about 60,000 km will have to be constructed annually during 1960-62, not an unreasonable amount based on past performance. Construction of national roads will be included in the target for 1962, but apparently the major objective is to expand the intraprovincial highway systems with emphasis on the construction of simple highways.

IV. Inputs in Highway ConstructionA. Capital Investment

During the First Five Year Plan (1953-57) in Communist China, total investment for highway construction amounted to approximately

* According to the Chinese Communists, only a part of this figure is included in the total of 153,000 km for total highway construction and repair.

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1.12 billion yuan. 16/ This amount constituted a minor share, about 12 percent, of the total of more than 9 billion yuan invested in transportation and communications and only about 2 percent of the total capital investment of 55 billion yuan. 17/

Of the total of 1.12 billion yuan invested for highway construction, expenditures by the central government amounted to more than one-half, or 704 million yuan. This amount was an increase of 21 percent above the plan figure of 582 million yuan. The remainder of the highway construction investment, some 414 million yuan,* was spent by local authorities. 18/

In Communist China, investment in road construction is broken down into the cost of the road bed (40 percent**), bridges and culverts (20 percent), surface (35 percent), and construction of auxiliary structures such as signs and railings (5 percent).

Direct costs in road construction constitute about 86 percent of the total cost (investment), of which materials constitute about 70 percent, wages 8 percent, and equipment 8 percent. Indirect costs, constituting the remaining 14 percent, cover administrative expenses and other indirect costs.

From 1949 through 1952, most of the funds spent on highway construction were allocated for the reconstruction of the existing highway network, with the remainder going for the construction of new roads. During the next 5 years (1953-57), construction of new roads absorbed a major share of total highway investment. Based on the amount of mileage added and the amount of investment, roads constructed by the central government averaged about 58,000 yuan per kilometer, and those constructed by local authorities averaged about 3,700 yuan per kilometer.***

During the First Five Year Plan the major share of investment by the central government was allocated for the construction of roads in frontier regions and minority areas, as shown in Table 2.[†] Because these roads were built through mountainous and difficult terrain, the average cost per kilometer was high. Reports of construction costs for individual roads in these remote areas tend to support the average cost

* this sum includes an estimated cost of compulsory civilian labor.

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** Figures in parentheses are estimates of the percent of total cost.

*** The central government constructed 12,000 km at an investment of 704,450,000 yuan; local authorities constructed 112,000 km at an estimated investment of 413,670,000 yuan.

[†] Table 2 follows on p. 10.

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Table 2

Communist China: Distribution of Highway Investment
by the Central Government
1953-57

Area	Share of Total Investment (Percent)	Amount of Investment (Million Yuan) <u>a/</u>	Length of Highways Constructed As of the End of 1957 (Kilometers)	Average Cost per Kilometer (Yuan)
Entire country	<u>100</u>	<u>704</u> <u>b/</u>	<u>12,000</u> <u>c/</u>	58,000 <u>d/</u>
Frontier regions and minority areas	66 <u>e/</u>	465	7,300 <u>f/</u>	64,000
Remainder of country	34	239	4,700	51,000

a. Yuan values in this table are believed to be in current yuan.

b. 19/

c. 20/

d. Derived from unrounded data.

e. 21/

f. Of the total length of roads constructed, 61 percent were constructed in frontier regions and minority areas. 22/

of 64,000 yuan per kilometer. The 506-km Ch'eng-tu - A-pa highway in Szechwan Province (see the accompanying photograph, Figure 2*), completed in 1954, cost more than 60,000 yuan per kilometer.** 23/ The Sikang-Tibet and Tsinghai-Tibet highways together cost a total of 300 million yuan, averaging about 69,000 yuan per kilometer.*** 24/

* P. 13, below.

** This highway was constructed as a Class V highway. See V, A, p. 14, below.

*** The Tsinghai-Tibet highway may have averaged more than 69,000 yuan per kilometer. When it was reported as completed in 1954, bridges and culverts had not been constructed. Completion of construction apparently was intended with the announcements that the highway would be "improved" in 1956 and "reconstructed" in 1957. 25/

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Throughout the rest of the country, central government funds reportedly were used for the construction of new roads, but it is believed that the major part went for improvement of the existing highway system. Because of the poor condition of the roads, the cost of this improvement was tantamount to new construction. The average of 51,000 yuan per kilometer, therefore, is not too high for the amount of construction performed.

B. Labor Force

Even as late as 1960 in Communist China, the bulk of highway construction was still performed by manual labor* (see the accompanying photograph, Figure 3**). 26/ By that time a permanent highway construction labor force was functioning at national, local, and urban levels, but the size of this labor force was small, numbering only about 10,000 technicians and skilled workers. 27/

In addition, members of the Peoples Liberation Army (PLA) contributed significant amounts of labor for construction of the highway network. During the 10-year period 1949-58 the PLA constructed 13,900 km of highways, including the construction of the 2,255-km Sinkiang-Tibet road, which was reported as completed in 1957. 28/ The PLA not only participated in the construction of roads serving the national interest but also probably contributed labor for road building at local levels, especially during the crash program in 1958.

The bulk of the labor force for road construction was made up of unskilled peasants recruited locally in the slack farming season.*** This labor force was used for the construction of all types of roads and probably was exclusively responsible for the construction of simple highways. In the 3-year period 1956-58, about 750 million man-days of labor† were contributed by the peasant labor force for the construction of simple highways alone.

* Heavy construction equipment for road building is practically nonexistent. Some bulldozers and heavy rollers, imports from the USSR or old Japanese equipment, are used, but the use of picks, shovels, hand tampers, primitive spreaders, and manually pulled rollers prevails.

** P. 13, below.

*** In addition, penal labor was used, and all types of civilians contributed labor on a short-term basis.

† In the period 1956-58 a total of 200,000 km of simple highways was constructed. The Chinese Communists estimate that on an average each kilometer of simple road requires 7,500 cubic meters (cu m) of earth. 29/ At a rate of 2 cu m of earth moved per man per day, 750 million man-days of labor would be required for the construction of 200,000 km of simple roads.

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With the formulation of plans in 1960 for increasing the length of the intraprovincial highway system during the next 3 to 8 years, 30/ dependence on manual labor for the construction of roads will continue for some time to come.

C. Materials

In Communist China, there are primarily two types of roads: soil-aggregate roads and natural earth roads. Probably less than 1 percent of the total length of 480,000 km claimed to be in operation in 1960 had stone block or bituminous or concrete surfaces.

Materials for road construction are procured locally, an effective low-cost method, provided construction standards can be maintained. Gravel, crushed stone, and sand are available in most areas of mainland China except where there are extensive alluvium and loess deposits. In areas where stone is not readily available, brickbats are used, and they are obtained as a waste product (culls) from brick plants and from demolition of old city walls or buildings. For soil stabilization* of the surface of natural earth roads, various soil mixtures, lime, liquid bituminous materials, salt,** and industrial waste materials such as slag and cinders are used.***

Other materials used for road surfacing are bituminous materials (asphalt and tars) and cement. Aside from streets in a few urban areas and roads in petroleum refining areas, however, the use of asphalt is limited. Probably most of the so-called asphalt roads are actually oiled-earth roads.* The use of cement for surfacing is even more limited than the use of bituminous materials. Except for the Peking - T'ang-ku highway† (see the accompanying photographs, Figures 4 and 5††) or in

* See the glossary, Appendix A, p. 21, below.

** In the Tsaidam Basin a section of the Ka-erh-mu (Golmo) - Ta-ch'ai-tan road, called the crystal road, has a surface of rock salt. 31/

*** In the US a combination of oyster shells, sand, and muck has been effectively used by a county in Florida for soil stabilization. 32/

† This highway was constructed before 1949 and was paved with a 3-meter-wide concrete surface. Apparently little or no maintenance was carried out under the Chinese Communists after 1949. By 1955 the surface of the highway was in very poor condition as a result of the increased volume of traffic, increased heavy loads, and severe damage from floods and frost heave. In 1955, under Soviet supervision, the entire highway was improved. The road was widened, and part of the road was rerouted. In some sections the old pavement was reclaimed through major repair. In other sections the original surface was retired, and the roadbed was entirely rebuilt. Where Footnotes continued on p. 147

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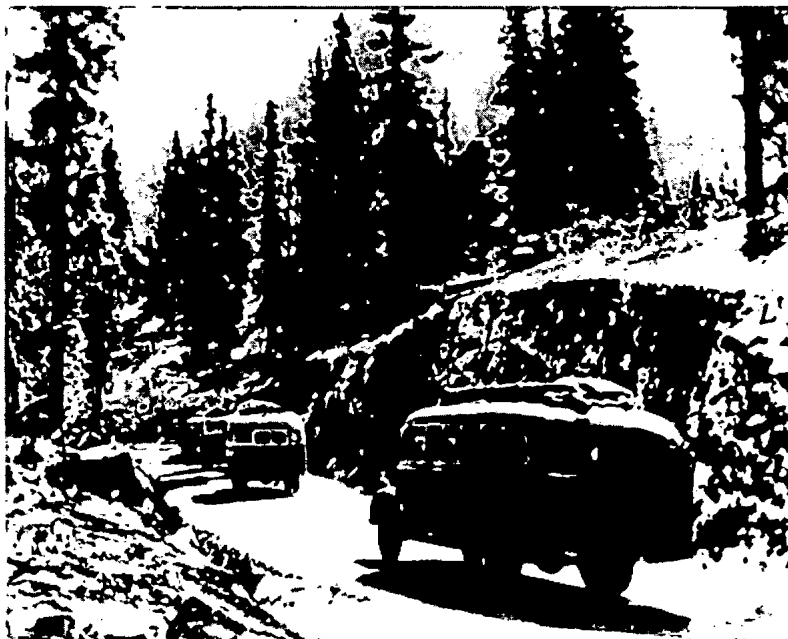


Figure 2. Communist China: Section of the Ch'eng-tu - A-pa Highway, Szechwan Province



Figure 3. Communist China: Manually Pulled Roller in Use on a Road Under Construction near Peking, Hopeh Province

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the vicinity of large cities, concrete road surfaces are practically nonexistent in mainland China. A low-grade cement, however, apparently is used as a binder in surfacing some types of soil-aggregate roads, and a higher grade of cement is used for bridges on highways.

V. StandardsA. Design and Construction

Standards or specifications for the construction of roads, ranging in engineering complexity from natural earth roads to concrete surfaced highways, were drawn up early (in 1950-53) based on Soviet methods. A highway was classified by the speed, width of the roadbed, number of lanes, grade, and the like for which the road was designed. As construction techniques improved, construction standards were adhered to more closely. Roads of higher classification were built, and existing roads were classified or reclassified as a result of the amount of improvement performed on them.

Before 1955, highways in Communist China were divided into six classes, not including simple highways. Because the length of these simple highways increased substantially after 1956, it was proposed in 1958 that they be included and classified as Class VI-B. The design specifications for the various classes of highways in 1958 are shown in Table 3.*

Considering the design specifications for the various classes of roads and the type of surfaces believed to exist on the majority of roads in Communist China in 1960, a rough estimate was made of the kind of surface found on each class of highway, as shown in Table 4.**

During the period 1953-60 a resorting and upgrading of classes of roads occurred from time to time, brought about by changes in extension of the road system, increased transport demands, and improvement of the road surface to allow greater carrying capacity. Selection of the class of highway depended on the amount of traffic to be carried and the nature of its function. The classes of highways in 1958

new surfacing was laid, precast concrete slabs were used. The use of precast concrete slabs on this road, the first road on which they were used in Communist China, was by way of an experiment. There is no indication that precast concrete slabs have been used on other roads since that time. 33/

†† P. 15, below.

* Table 3 follows on p. 16.

** Table 4 follows on p. 17.

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Figure 4. Communist China: Unimproved Section of the Peking - T'ang-ku Highway

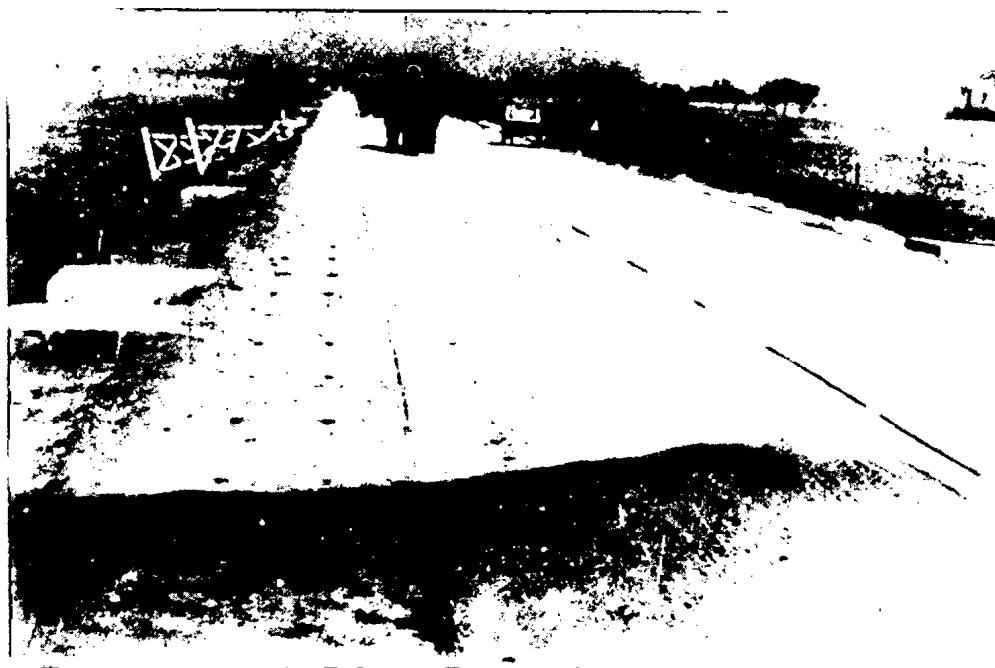


Figure 5. Communist China: Improved Section of the Peking - T'ang-ku Highway, Showing Precast Concrete Slabs in Place

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Table 3

Communist China: Design Specifications for Classes of Highways a/
1958

Specifications	Units	Classes of Highways <u>b/</u>						
		I <u>c/</u>	II <u>c/</u>	III	IV	V	VI-A	VI-B
Designed maximum speeds <u>d/</u>	Miles per hour	75	62	50	37	25	16	16
Lanes	Number	4	2	2	2	2	1	1
Width of each lane <u>e/</u>	Feet	12	12	12	12	12	12	10
Width of surface <u>e/</u>	Feet	46	23	23	23	23	20	10 to 15
Width of roadbed <u>e/</u>	Feet	75	39	36	33	30	26	15 to 21
Minimum radius of curves <u>f/</u>	Feet	1,968	1,312	820	410	164	66	49
Length of vision								
When stopping	Feet	492	410	328	246	164	115	82
When passing	Feet	N.A.	820	656	492	328	230	N.A.
Maximum grade <u>g/</u>								
Level terrain	Percent	3	4	4	4	5	5	5
Mountainous terrain	Percent	N.A.	N.A.	5	5	7	8	8

- a. 34/
b. Highways of Classes I, II, and III are designed particularly for high-speed motorized traffic, and pedestrian and animal-drawn traffic on them is prohibited. A separate or auxiliary road or additional lanes should be provided. On highways of Classes IV, V, and VI in level terrain, common use by both types of traffic may be permitted without construction of an auxiliary road or lane.
c. 1955 specifications for Classes I and II were revised little, if at all, in 1958.
d. The speeds given are for light vehicles. The speed of trailer trucks would be slower. 1955 specifications were revised to allow for a moderate increase in speed for Classes III and IV.
e. The widths of each lane are greater than those formerly regarded as sufficient in order to provide more space for truck-trailer trains. In general, the width of a road surface should be 23 feet; where traffic is not heavy, the width can be 20 feet. The width of the roadbed, in general, should be 26 to 30 feet, but in difficult terrain the width may be 23 to 26 feet.
f. No change has been made in the radius of curvature of hairpin bends, but the road surfaces should be widened at those points. The minimum radius of curve for level roads is 66 feet; for hairpin bends, 49 feet.
g. For roads in areas of rolling terrain, specifications should be modified for critical sections of the road. If the major portion of the road is located on level land, specifications for level land should be followed. Similarly, if the major portion is in mountainous areas, specifications for mountainous terrain should be followed.

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Table 4

Communist China: Estimate of the Kinds of Surface
on the Classes of Highways
1960

<u>Class of Highway</u>	<u>Kind of Surface ^{a/}</u>
I	Concrete or bituminous (No. 4)
II	Bituminous (No. 2 and No. 3)
III, IV, V	Oil-treated or soil-cement; water-bound or traffic-bound rubble or gravel
VI-A	Stabilized natural earth
VI-B	Natural earth

a. See the glossary, Appendix A, p. 21. Numbers in the table refer to the types of pavement listed under Bituminous pavements in the glossary.

considered to be "suitable" for specific national and intraprovincial service are shown in Table 5.* The selection of classes by the Chinese Communists for the functions listed in the table, however, indicates a goal for future attainment. Not only are national, interprovincial, and important provincial roads referred to as "international highways," but the classes of roads assigned to the various functions indicate a higher grade road system than actually existed in 1958-60. Roads designated as national highways, therefore, would necessarily include roads with a lower grade of surface and lower capacity such as Class IV and V highways. Furthermore, it is unlikely that service highways were other than Class VI-B highways, or roads with a natural earth surface.

The nature of the road system in Communist China in 1960 was much the same as the one that the Communists took over in 1949 -- that is, the road system was made up primarily of soil-aggregate and natural earth roads. Most of the new soil-aggregate roads were constructed by the central government and probably were relatively of better quality than those constructed by local authorities. Probably very few of the number of macadam roads constructed had bituminous-bound or cement-bound surfaces. Although some new roads were built with concrete and bituminous surfaces, road construction had such a low priority that only very limited amounts of cement and bituminous

* Table 5 follows on p. 18.

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Table 5

Communist China: Highway Classification Selection
by Functional Use a/
1958

Functional Description	Class of Highway <u>b/</u>
Primary international highways: highways that connect with political, economic, and cultural centers of national significance; interprovincial highways; and highways that connect with major mining, industrial, and transportation centers	I, II, III <u>c/</u>
Secondary international highways: intraprovincial highways that connect with important political, economic, and cultural centers; highways that connect with important mining and industrial centers, large farms and ranches, important harbors and river ports, railroad stations, and airports	II, III, IV <u>c/</u>
Intraprovincial highways: highways that connect with special districts, hsiens, and municipalities within the province and highways that connect with medium-scale mines, farms, and industrial and transportation centers	IV, V, VI <u>d/</u>
Service highways: highways between hsiens, between hsiens and communes, and between communes and intracommune highways	V, VI <u>e/</u>

a. 35/

b. For specifications and surfaces of classes of highways, see Tables 3 and 4, pp. 16 and 17, respectively, above.

c. The length of roads classified as Class I and Class II highways was negligible in relation to the total length of roads. In 1958 the greatest length of these roads, both "primary and secondary international highways," probably was composed of Class IV and Class V highways.

d. There probably were a limited number of Class IV highways in 1958. The majority of these roads were Class V and VI-A highways.

e. All of these roads probably were Class VI-B highways.

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materials were allocated even for the construction of national roads. The concrete and bituminous roads that were constructed suffered as a result of below-standard preparation of the roadbed or poor product-mix for the surface.

Improvement of the road system included adding layers of industrial waste and rubble or gravel to road surfaces, widening roadbeds and providing better drainage, building cutoffs for better alignment, and reducing the number of hairpin turns where it was feasible. The capacity of old bridges was increased, and new bridges were constructed to eliminate the number of ferry crossings.

The Chinese Communists consider their present roads as transitional and imply that in the future these roads will be used as a base and will be improved by adding concrete and asphalt surfaces. This construction method can be effective provided that the road is constructed initially up to specifications and provided that the wearing surface is properly maintained. However, because most of the roads have not been constructed up to specifications and because sustained effective maintenance has not been carried out, improvement will necessitate retiring the surface and reconstructing the roadbed before a high-grade surface can be applied. The cost of this improvement, therefore, will prove to be almost equivalent to the cost of new construction.

B. Maintenance

A highway system is only as good as the amount and quality of maintenance performed. Proper maintenance not only prolongs the life of the wearing surface of roads but also insures sustained movement of traffic and saves on fuel, tires, and parts.

Soil-aggregate and natural earth roads, the major types of roads in Communist China in 1960, require constant maintenance to keep the surface smooth and firm and free from loose materials and to reduce mud and dust. Failures of soil-aggregate and natural earth roads result from improper drainage, poorly mixed materials, or an inadequate foundation. Because the road system in Communist China was not constructed up to specifications and because frequent failures occurred, the cost of maintaining the road system (not including simple highways) probably amounted to nearly 100 million yuan annually for the years 1957-60.*

* It is estimated that for the 4-year period the annual average length of soil-aggregate roads maintained was about 200,000 km. The annual cost of maintaining this type of road ranged from 360 to 400 yuan per kilometer. 36/

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For the purpose of maintaining roads, corvée labor began to be mobilized early in 1950. At that time the major objective was to keep the roads just passable. As traffic increased and the road system was extended, organized maintenance teams composed of locally recruited labor were established along national routes. In addition, many important provincial routes were maintained by loosely organized teams supplemented by part-time mass labor. During the First Five Year Plan (1953-57) alone, nearly 100 million man-days of labor were used for maintenance of these roads. The remainder of the road system, approximately 40 percent of the total length, was left to the discretion of peasants on a part-time basis. 37/ In 1958 the transport demands during the "leap forward" movement necessitated better organized maintenance work. Heavily loaded trucks and trailers as well as big cart wheels literally plowed up the roads. In the entire country, more than 100,000 persons were organized especially for the maintenance of roads. With continued hard use of the road system in 1959, an urgent need was felt for the establishment of a permanent maintenance force. This maintenance force was to work on both national and other important roads primarily suited for short-distance hauls. Maintenance of the remainder of the road system was to continue to be on a makeshift part-time basis. 38/ In 1959 the total number of persons maintaining roads on both a permanent and a part-time basis reportedly reached 200,000, an average of one person for every 2 km of road. 39/

Maintenance work consisted of protecting the surface of roads and keeping them open in all kinds of weather. Maintenance workers were responsible for filling in ruts and potholes and for spreading sand and other materials to keep the surface of roads smooth. In addition, they were to keep roads free of snow and to repair damage from floods and frost heave. Maintenance workers were responsible also for maintaining and repairing shoulders, ditches, and culverts and for planting trees along the right of way, but apparently these duties were carried out only to a limited extent.

There is little indication that the character of the road system in Communist China will change greatly during the next 10 years (1960-70). With the continued construction of soil-aggregate roads and an increase in the construction of natural earth roads, the problem of maintaining such a highway system, subject to rapid deterioration, will increase annually for some time to come.

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APPENDIX A

GLOSSARY

Information contained in this glossary is based on standard US practices.

Asphalts: In general, asphalts used for road surfacing are obtained from both natural deposits and as a byproduct of petroleum refining. Natural asphalts occur in surface deposits (lake asphalts) or are impregnated in porous rock (rock asphalts). The principal source of asphalt, however, is from the distillation of asphaltic-base petroleum.

Bituminous materials. (See Asphalts and Tars.)

Bituminous pavements: There are four general types of bituminous pavements: (1) surface treatments, consisting of a thin bituminous layer usually less than three-fourths of an inch of penetration on a prepared road surface; (2) road mixes, in which the bituminous material is mixed with the aggregate by manipulation on the roadbed; (3) bituminous macadam, in which the top course of broken stone is penetrated with bituminous binder; and (4) bituminous concrete and sheet asphalt, in which aggregates and bituminous material are mixed under controlled conditions at a central plant.

Improvement: Improvement is a term used to describe the degree of capital outlay required for the betterment of a road. The cost of routine repair work is included in the maintenance budget. Where extensive capital outlay is required for repair of a road, it is no longer considered maintenance but improvement.

Macadam roads: The term macadam has come to mean road surfaces and bases constructed of crushed or "broken" stone fragments cemented together by action of traffic or by rolling and water. The term is applied also to broken-stone surfaces and bases where aggregate particles are bound by cement or bituminous materials. Macadam roads are flexible or semirigid in nature, so that preparation and conditions of the subgrade are vital. Failures or deformation in the subgrade show up in the base and wearing surface. Surface irregularities in this type of road are much more difficult to correct than in some other types of construction.

Maintenance: Maintenance operations consist of maintaining the road surface, shoulders, drainage and drainage structures, roadsides, and bridges. Maintenance operations also include snow and ice control and special services such as relining pavements and repainting signs.

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Natural earth roads: Natural earth roads are the lowest type of roads and are composed of natural soils as they exist. The natural soil is bladed to the center to form a crown with a ditch along each side. The condition of such roads depends on the nature of the soil and the effectiveness of drainage. Where the natural soil is gravelly or sand mixed with some clay, the surface will be fairly stable; in silty or clay soils the surface will be muddy during rains and will dry out into ruts at other times.

Oiled-earth roads: Oiled-earth roads represent a type of surface treatment that is quite different from other types of bituminous stabilization. No mechanical mixing is required in this construction process, as the liquid bituminous material is simply applied to a properly prepared natural soil surface. The material penetrates a short distance, forming a thin "stabilized" surface capable of supporting a limited number of light vehicles. This type of construction is widely used in areas where cracked or uncracked residual oils are cheaply available.

Repair: Repair work should not be considered as an independent function. The cost of routine repair work is included in the maintenance budget. When extensive capital outlay is required for the betterment of a road, repair constitutes capital improvement.

Soil-cement roads: Soil-cement roads represent a type of soil stabilization that involves the incorporation of portland cement, in amounts generally varying from 7 to 14 percent by volume of the compacted mixture, with naturally occurring or selected soils or soil-aggregate mixtures. This type of construction is generally employed in the formation of base courses, usually with thicknesses varying from 4 to 6 inches. A soil-cement mixture may serve as a base for a thin wearing surface that will be subjected to light or medium traffic or as a support for a high type of flexible or rigid pavement.

Sand-clay roads: Sand-clay roads are a type of soil-aggregate roads that are built by artificial or natural mixtures of sand and clay to produce a stabilized road.

Soil-aggregate mixtures: A wide variety of materials is used in soil-aggregate mixtures, including sand-clay, gravel, and stone or slag screenings; sand, crushed stone, or slag combined with soil as a binder; and various combinations of these materials.

Soil-aggregate roads: Soil-aggregate roads are roads which consist of a substantial layer of a properly proportioned and blended mixture of soil and aggregate compacted to form a road that is capable of supporting traffic in all weather conditions. This type of road is

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taken to include those constructed from sand-clay mixes and various coarse-graded aggregate materials that generally require smaller maintenance operations. Coarse-graded aggregate surfaces consist of a wide range of mineral aggregates such as gravel, crushed stone, crushed slag, or similar substances combined with clay, stone dust, or other binder material to produce stability. Water-bound and traffic-bound macadam surfaces are included in the coarse aggregate group. In addition to serving as wearing courses, generally for light traffic, soil-aggregate mixtures are widely used as bases and subbases.

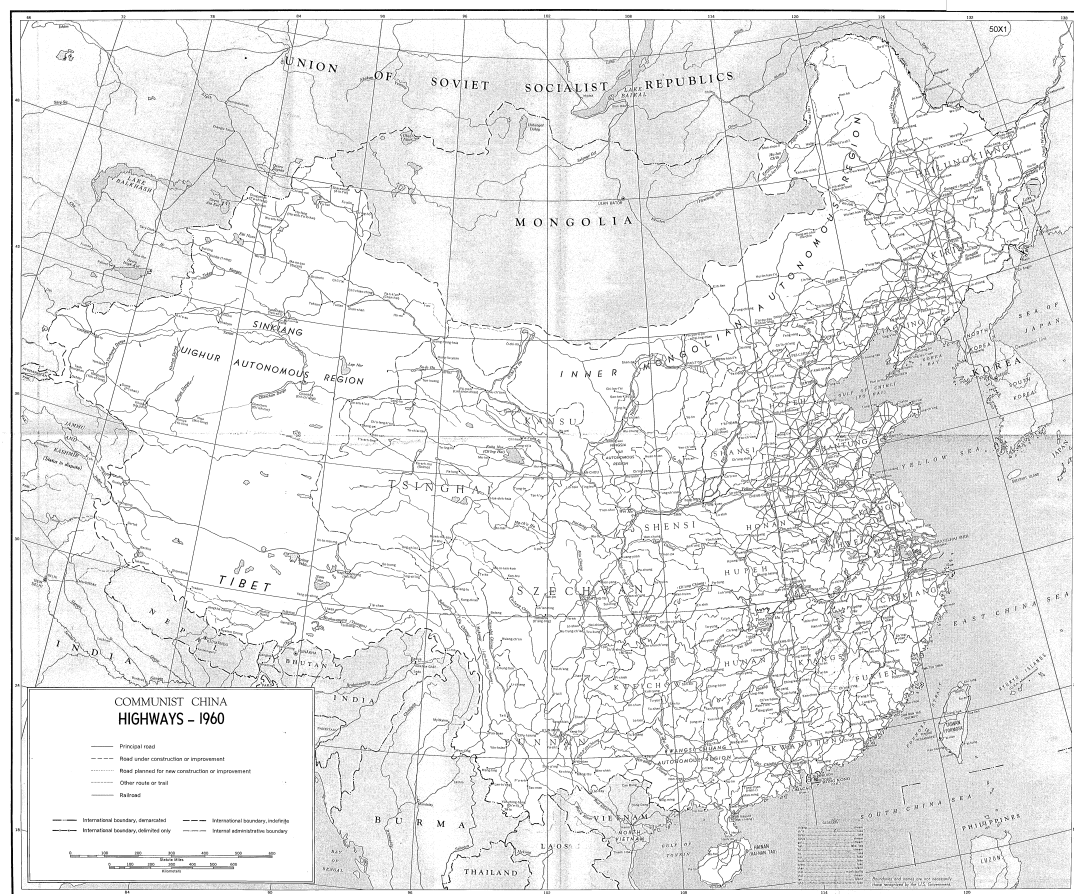
Soil stabilization: Soil stabilization may be defined as the combination and manipulation of soils, with or without admixtures, to produce a firm mass that is capable of supporting traffic in all weather conditions. In other words, a stabilized road surface is one that will stay put, and stabilization is the process by which it has been made that way. In some instances, unfavorable natural soils are modified through use of gravel or of crushed stone or clay binder. In other instances, bituminous materials, cement, salt, or lime are used for effective stabilization. The type and degree of stabilization required in any given instance is largely a function of the availability and cost of the required materials, as well as the use that is to be made of the stabilized soil mixture. Stabilized soil mixtures lend themselves readily to the process of "stage construction." A properly designed stabilized soil mixture might function as a wearing surface, receive a thin bituminous surface treatment as traffic increases, and eventually serve as a support for a high type of bituminous pavement for a heavy volume of traffic.

Tars: Tars used in construction are produced from coal (coal and coke-oven tar) or from oil vapors (water-gas tar). Tars can be used as prime coats (to stabilize), tack coats (to bond), and seal coats (to waterproof).

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